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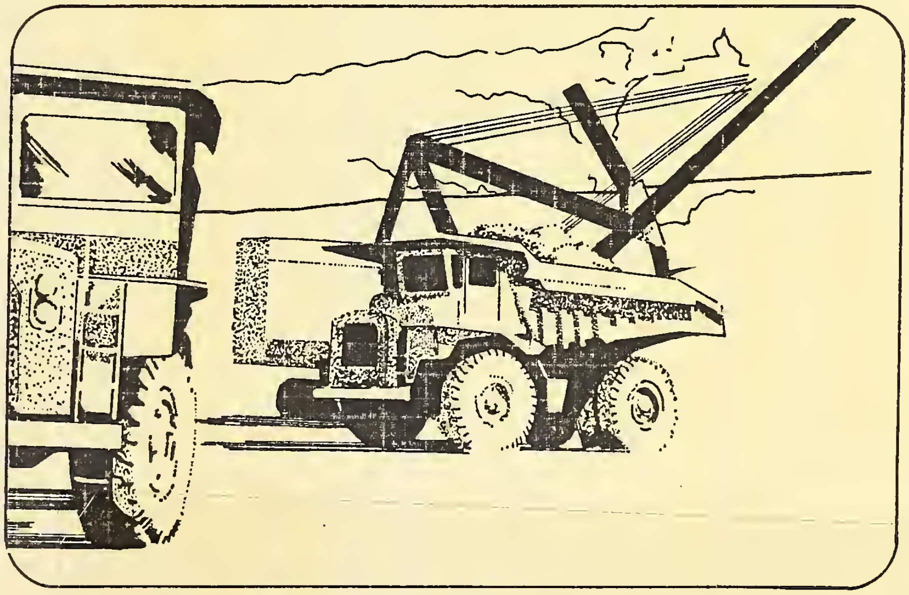
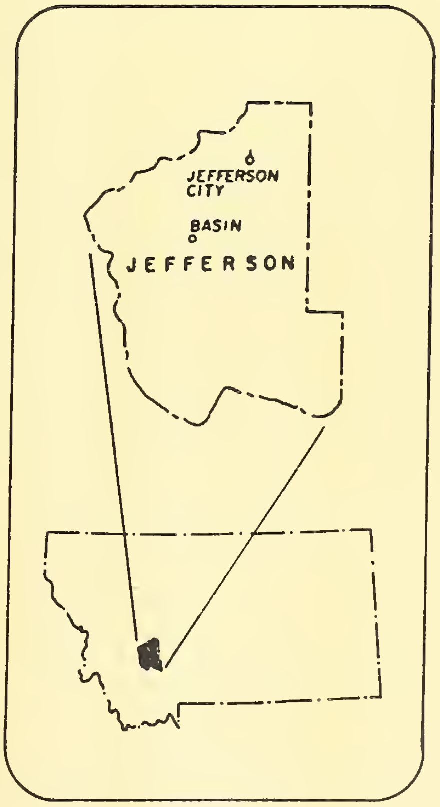
ENVIRONMENTAL BASELINE STUDY PLAN, MONTANA TUNNELS PROJECT

JEFFERSON COUNTY, MONTANA

Centennial Minerals Ltd





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ENVIRONMENTAL BASELINE STUDY PLAN
MONTANA TUNNELS PROJECT
JEFFERSON COUNTY, MONTANA

DRAFT

for

Montana Department of State Lands
1625 Eleventh Avenue
Helena, Montana 59620

by

Centennial Minerals Ltd.
5488 Gunbarrel Road
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in cordination with

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April 13, 1984

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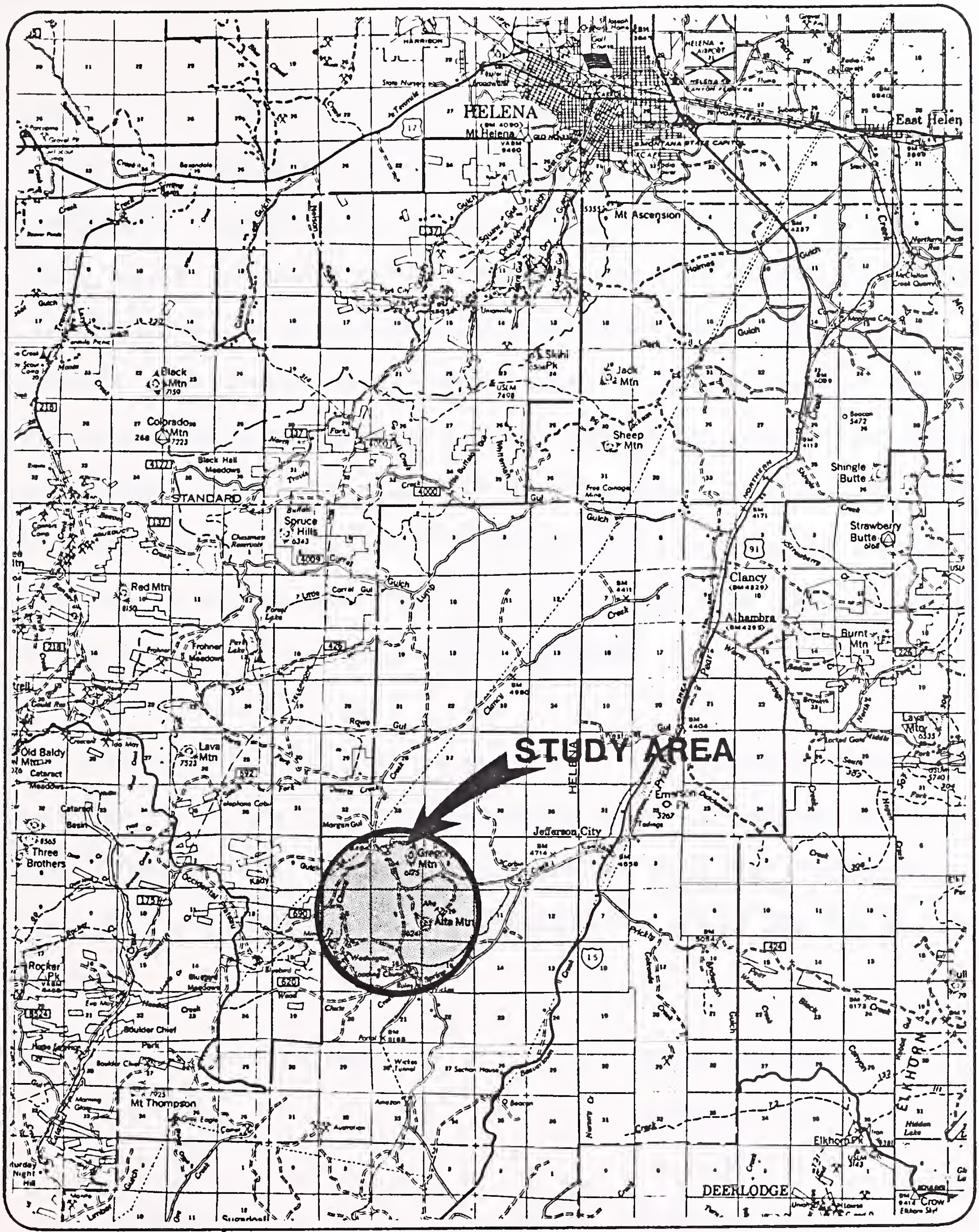
INTRODUCTION

INTRODUCTION

The proposed Montana Tunnels Project will require an operating permit from the Montana Department of State Lands. The operating permit, issued under the provisions of the Montana Metal Mine Reclamation Act (Title 82, Chapter 4, Part 3, MCA), requires an environmental baseline investigation of the area that may be affected by the mining or processing operations. The objective of the baseline studies is to develop a comprehensive understanding of environmental conditions in and near the proposed operation. This information is utilized in preparation of a comprehensive operating plan and a reclamation plan for the project. To assure the baseline environmental studies are of the appropriate scope and intensity, Centennial Minerals, Ltd. has developed this detailed study plan that describes each of the proposed baseline investigations for review by the DSL.

The Centennial Minerals Project will be an open pit gold mine in Jefferson County, Montana located about five miles southwest of Jefferson City, Montana (Figure 1). The ore will be processed in a mill and gold will be removed from flotation concentrates by use of a cyanide leach. As background for this study plan, a description of the mining and ore processing operation is presented. All baseline studies will follow the DSL guideline and the design and conduct of each study will be closely coordinated with technical staff of the DSL Hard Rock Bureau.



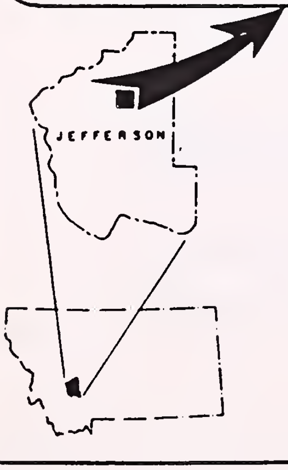


FIGURE I

LOCATION MAP
MONTANA TUNNELS PROJECT

Concurrent with the baseline environmental studies, Centennial Minerals is working on detailed engineering of the mining and ore processing operations in addition to engineering of sites selected for tailings ponds, waste rock dumps and mine and ore processing facilities. The overall objective of Centennial's pre-mining investigations is to complete comprehensive environmental baseline studies, develop mining and ore processing procedures and conduct needed geotechnical and other engineering studies. This work will be integrated to provide the basic framework for understanding the relationship between the proposed operation and environmental resources and to provide information needed for the project environmental impact statement.

The environmental baseline studies will be conducted under the direction of Mr. Roy Faverty of Centennial Minerals, Ltd. and Mr. M. K. Botz of Hydrometrics. Specific environmental baseline studies to be completed and organizations responsible for these studies are as follows.

Air Resources/Climatology - Bison Engineering
Hydrology - Hydrometrics
Wildlife - Westech
Vegetation - Westech
Geology and Soils - Hydrometrics
Land Use, Energy, Transportation Aesthetics and Noise Levels - Hydrometrics and Centennial Minerals
Socioeconomic Human Environment - Mountain International
Cultural Resources - GCM Services, Inc.

BASELINE STUDY PLAN

BASELINE STUDY PLAN

The scope and intensity of the baseline studies will be designed to meet all requirements of the Montana Metal Mine Reclamation Act and rules and the guideline pursuant to that act. Each of these studies are designed to meet the needs of Centennial Minerals, Ltd. and the requirements of the DSL. All the environmental baseline studies are designed to meet the informational requirements for a project Environmental Impact Statement.

AIR RESOURCES/CLIMATOLOGY

Before the proposed mine and mill facility can be permitted and built, the State of Montana requires a complete analysis be made to assure that airborne emissions from all sources will not exceed any state and federal air quality standards. This is a legal requirement which must be completed before permits can be obtained.

It is our experience with mines and mills, as envisioned in the proposed project, that the limiting standard is increment consumption of particulate matter under the state and federal Prevention of Significant Deterioration (PSD) requirements. While such sources are generally not required to undergo extensive PSD review, the impact of their emissions cannot exceed the value established for the classification of the area where they are to be built. The proposed project is a Class II area with U. S. Forest Service lands on the western boundary.

To determine impacts prior to construction and operation, the agencies require baseline meteorological and air quality data. This information is used to model the projected emissions from the proposed project using approved models. Generally, a screening modeling analysis is recommended before a refined analysis is conducted. The screening analysis will provide an approximation of

the maximum downwind impacts and the location of such impacts. The screening analysis will also give quick preliminary results that are generally conservative (i.e. higher numbers than actually expected). If the results of the screening analysis indicate that any increment or standard may be threatened, a refined dispersion modeling analysis is needed. Generally, site specific meteorological monitoring data is required for the refined dispersion modeling. Topography, impacts on elevated terrain, and location of plant boundaries are key considerations in such analysis.

Aesthetics and noise, while needing to be covered in the environmental assessment, are not considered to be crucial to the project.

Air Baseline Study Plan

To design a study plan for air resources requires a knowledge of applicable regulations, available data in the area, and the relationship between the proposed project and the resource. The study plan would be designed to meet baseline requirements and at the same time provide the information and analysis to prepare any required EIS assessment. The air plan would be developed in conjunction with DSL and DHES personnel and be integrated into the overall study plan. The task would primarily involve coordination and writing.

Meteorological Monitoring

The baseline meteorological monitoring system would be designed to meet DSL and DHES requirements and also the PSD monitoring guidelines. Critical atmospheric parameters for modeling would include wind speed, wind direction and temperature. The meteorological station will be sited after consultation and approval of the appropriate agencies.

The meteorological instruments will be installed on a ten (10)meter tower and operated a minimum of six (6) months. This includes both routine operation and maintenance in addition to periodic calibration associated with quality assurance requirements. Data would be reduced on a monthly basis, analyzed and coorelated with other data in the area on a quarterly basis and reported on a quarterly basis. The base meteorological system provides for the analog recording of information on strip charts. An option proposed is to equip the system with a data logger to record the information in a digital format. This option would be cost effective if the system is operated for a year or longer.

Air Quality Monitoring (Option)

DHES and DSL in the past on similar projects have required the installation and operation of air quality monitoring stations for baseline information. However, in some situations they have not

required the baseline monitoring but have required post-operational monitoring. For this reason this task has been specified as an option.

If pre-monitoring is required the agencies generally require two air quality stations (one upwind and one downwind from the area of principle activity). The downwind site is to be located near the location of the maximum ambient air pollution concentration resulting from the proposed mine and mill complex. We generally site the monitor at a location near the boundary of the permitted area as far downwind as possible taking into account access, power availability and security. At the downwind site two co-located samplers are required to measure precision of the monitoring network.

Particulate matter which is expected to constitute the only significant air emission from the proposed project will be monitored by total suspended particulate (TSP) high volume (HV) samplers. The HV samplers will be installed on top of 2 meter high platforms at the two sites (1 at upwind site and 2 at downwind site). The sampler selected is a General Metal Works GMWL-2000H High Volume Air Sampler. This unit is equipped with a pressure transducer recorders (making it an EPA Reference Method) and a Model GMW-70 7-day skip timer.

The instrumentation would be installed after consultation and approval by DHES and DSL and would meet all the siting criteria required by EPA. The sites, installation and initial calibrations will be documented and samples run every 6 days as required by EPA. Quarterly calibration audits will be performed along with any necessary preventative maintenance. The monitoring network will be maintained and operated for at least 6 months with the objective of achieving at least 90 percent data recovery.

Preliminary Assessment

The preliminary assessment should be early on in the project. Existing background data would be assembled and a preliminary estimate of emissions made from preliminary design information. Location of sources, terrain and estimated emission would be input to an approved screening model. The model that would probably be used would be the Valley Model. Results from the initial run of the model would be reviewed and changes made in controls, process or location as deemed desirable. The model would be rerun and the results reviewed. This iteration would proceed until it was evident that additional benefit would not be gained, probably three to four model runs. Results could be scaled up or down to some degree for different production rates. Results would also be useful in siting the ambient air quality monitoring network.

Refined Analysis

Based on the proposed size of the project, results from similar sources and the proximity of the proposed mine and mill to property boundaries, there is a good possibility that the results from the screening model will exceed allowable Class II increment limits for particulate matter. If this is the case, a refined analysis using the Industrial Source Complex (ISC) model would be accomplished. Representative site meteorological data would be used in the ISC model. Both data from the meteorological monitoring and from coorelations with other data in the area would be reviewed for applicability to the modeling effort.

Refined emission estimates and controls would be caluclated from the final design of the process and mining operation. These emission estimates, time weighted and corrected for operational procedures, would be input to the ISC model at the appropriate coordinates. Deposition functions would be utilized in the model reflecting the source of the emissions. Iteration of the ISC modeling could be performed to help finalize controls and design.

Impact Analysis

The most important part of the baseline assessment is the potential impacts of the project. The time-averaging periods of interest in this analysis are the annual average concentrations and the 24 hour

average concentrations. The impacts predicted by the ISC model will be compared to state and federal air quality regulations to demonstrate compliance of the proposed operations. This includes both state and federal ambient air quality standards which will involve adding the model impacts to the established baseline concentrations. It also includes establishing compliance with regulations based on the 1977 Clean Air Act Amendments. This includes the PSD provisions.

Project alternatives must also be revived if these alternatives have air quality implications. Such alternatives will be examined to ensure adequate information is available to assess the effect on project emission rates.

The effectiveness of controls and mitigating measures will also be assessed. This will involve an estimate of the measure's effect in reducing or changing emission levels and subsequently an estimate of the change in impact for each measure.

Document Preparation

In this task a document will be prepared describing the baseline work and the results of the atmospheric analyses. The document will provide a summary of baseline conditions including climatological, meteorological and air quality data rquired for an EIS assessment. Climatological baseline will include parameters on temperature, precipitation, evaporation and humidity. Meteorological information

needed for dispersion analysis would include wind speed, wind direction, temperature and mixing height. Air quality data would include background levels of particulate matter in the area. Emission rates, control measures and alternatives will be described. Modeling methodology, results and impact analyses will be presented.

HYDROLOGY

This study plan has been developed based on a review of water resources information and an assessment of water resource issues of significance to the Montana Tunnels Project. The study plan is designed to collect baseline hydrologic data necessary for preparation of an application for an operating permit for the Montana Tunnels Project. The baseline studies are designed to meet all provisions of the Montana Metal Mine Reclamation Act (Title 2, Chapter 4, Part 3, MCA). The scope of study and level of detail are also designed to provide the necessary data for preparation of an Environmental Impact Statement, should that be required by DSL for the project. The hydrologic investigation will also evaluate water supply sources for the Montana Tunnels mining and milling operations.

This study plan is divided into two tasks. These are:

TASK 1. INVESTIGATION OF SURFACE WATER RESOURCES

TASK 2. INVESTIGATION OF GROUNDWATER RESOURCES

A detailed timetable and budget for completion of the Phase II water resources investigation have been completed. All work on the Montana Tunnels Project, including contacts with State and Federal agencies, will be closely coordinated with Mr. Roy Faverty of Centennial Minerals, Ltd.

Mr. M. K. Botz will be the project director and will be responsible for Hydrometrics' coordination and contacts. Project personnel and responsibilities are described in the personnel section.

TASK 1. INVESTIGATION OF SURFACE WATER RESOURCES

A map of affected watersheds will be prepared showing significant surface water features. The map scale will be 1:64,500 or 1:24,000, depending upon availability of USGS base topographic maps. This map will show the relationship of these features to the mine, mill facilities, tailings ponds and waste rock dumps. Surface water use in the general study area will be described and existing baseline data summarized.

Flow estimates of watersheds near the proposed mining and mineral processing area will be made both by direct measurement and by several calculation techniques. Peak flow will be estimated using a method developed by the U. S. Geological Survey. Average annual runoff will be estimated using runoff per unit area, channel geometry or other suitable techniques. A surface water monitoring system will be established and flows will be measured periodically through the spring, summer and fall of 1984 at several sites. Flow monitoring sites will be determined after reviewing the plan for the mining operation.

Baseline surface water quality data will be collected from watersheds in and near the project area. Seasonal data, including both low and

high flow periods, will be obtained. The scope and intensity of surface water quality sampling and analysis will be designed to determine seasonal variations in baseline water quality. Final selection of surface water sampling sites will depend on the mine operation plan and the location of tailings ponds, waste dumps and ore processing facilities.

A comprehensive surface water baseline monitoring plan will be developed. Baseline monitoring will be designed to integrate with monitoring conducted during the operational and post-mining phases of the project. An analytical schedule of water quality parameters is in Table 1. A quality assurance and quality control program plan will be incorporated into the baseline monitoring plan.

Methods used to obtain water resources data will be consistent with those described in the National Handbook of Recommended Methods for Water-Data Acquisition. Collection, storage and preservation of water samples will be in accordance with EPA procedures (EPA-600/4-82-029). Samples will be collected from streams and springs by the grab sample technique. All samples for dissolved constituents will be field filtered through a 0.45 micron filter. Samples will be cooled immediately after collection. Metals in water samples will be preserved in the field by addition of nitric acid to lower the pH to less than 2.0.

TABLE 1. PARAMETER LIST FOR WATER RESOURCES MONITORING

COMPLETE ANALYSIS

Specific Electrical Conductance (SC)
Temperature
Total Dissolved Solids (TDS)
pH
Sodium (Na)
Calcium (Ca)
Magnesium (Mg)
Bicarbonate (HCO_3)
Carbonate (CO_3)
Chloride (Cl)
Sulfate (SO_4)
Total Cyanide (CN)
Cyanide amenable to chlorination (CN)

Nitrate + Nitrite (as N)
Total alkalinity (as $CaCO_3$)
Total Hardness (as $CaCO_3$)
Zinc (Zn)
Iron (Fe)
Arsenic (As)
Mercury (Hg)
Lead (Pb)
Manganese (Mn)
Copper (Cu)
Flow or Static Water Level

Chemical analysis of water samples will be by procedures in 40 CFR 136 or methods shown to be equivalent.

Quality assurance in chemical analysis will be through submittal of blanks and duplicates and through the analysis of water quality standards and spikes. Periodically, control samples will be forwarded to two independent water quality laboratories. The analytical laboratories will be required to have an internal quality assurance program and maintain record books showing laboratory control procedures.

It is not anticipated that a surface water discharge permit (MPDES) will be required for the Montana Tunnels Project. Any contact with the Montana Department of Health, Water Quality Bureau regarding discharge permits or other issues will be coordinated with Centennial Minerals, Ltd.

TASK 2. INVESTIGATION OF GROUNDWATER RESOURCES

A discussion relating the regional geological setting and groundwater resources will be prepared based on published geologic data, data available from Centennial Minerals, Ltd and site examination. Water table or potentiometric maps will be prepared of the area near the mining and ore processing operation, if sufficient information is available. A discussion of depth to water, hydrostratigraphic units, flow regime and a cross section of the mine area showing hydrostratigraphic units will be prepared.

A groundwater monitoring program will be developed to obtain data from exploration test holes and geotechnical studies where possible. A system of groundwater monitoring wells will be installed to collect baseline data and will be used for groundwater monitoring throughout the life of the mine operations. The monitoring wells will utilize exploration or geotechnical and borings where possible. A substantial savings in drilling costs can be achieved by coordinating the groundwater investigations and other drilling programs. The groundwater monitoring sites will be sampled to provide baseline groundwater quality data. Table 1 is a list of water quality parameters that will be analyzed. Samples will be collected with a bailer or a submersible pump. Sample collection, preservation and analysis will be in accordance with EPA procedures (EPA-600/4-82-029, 600/4-79-020, 40CFR 136) or equivalent.

Quality assurance in chemical analysis will be through submittal of blanks and duplicates and through the analysis of control standards and spikes. Periodically, control samples will be forwarded to two independent water quality laboratories. The analytical laboratories will be required to have an internal quality assurance program and maintain record books showing laboratory control procedures.

A hydrologic inventory of all wells and springs within one mile of the proposed permit area will be included in the baseline groundwater study. Wells downgradient of the mine area outside the one mile buffer will be inventoried if it appears they may be affected by the proposed

mining activities. State water right records will be examined and field surveys will be conducted to identify wells and springs in the study area. Inventory data will include yield, water quality, completion data and ownership where possible. A map showing the location of all wells and springs will be prepared.

WILDLIFE

The following terrestrial wildlife study plan was developed for the Montana Tunnels project area, near Jefferson City, Montana. The study plan is based upon a brief field reconnaissance of the area; upon guidelines prepared by the Montana Department of State Lands (DSL); and on similar studies approved by DSL for large mining projects in Montana.

Major objectives of the study are:

- Perform a detailed literature review of the project area and vicinity, and of the wildlife resources of the area (including contact with the Montana Department of Fish, Wildlife and Parks, U. S. Forest Service and Bureau of Land Management);
- Map wildlife habitats in the study area and assess wildlife use of those habitats. Wildlife habitats will be defined by existing vegetation and physical features;
- Develop a list of all wildlife species that potentially occur in the area, and document as many species as possible through direct observation or observation of evidence. Skaar (1980) and Thompson (1982) suggest that there are about 213-252 birds, 52-59 mammals, eight reptiles and 4-5 amphibians in the region encompassing the study area. This list will be expanded or reduced in response to habitat availability, land use or other factors;
- Identify major species. Major species are defined as those of relative "importance" based on ecological vulnerability, social consid-

erations, and management costs and yields (Thompson, 1977; Hughes, 1978). Obtain, if possible, relative density estimates of major wildlife species;

- Show season or seasons of use of the study area by each major species;
- Document the known or suspected occurrence of threatened or endangered species, or their habitats.

The location and size of the proposed study area are shown in Figure 2. The ground study area will cover about 10½ mi^2 and was selected to include a 1-2 mile buffer around all potentially affected areas, as well as parts of the access roads from Jefferson City and Clancy. The ground study area is large enough to adequately sample wildlife habitats in proportion to their occurrence in and near affected sites. In addition, aerial surveys may extend 1-2 miles beyond the ground study area to provide a greater extent of information on big game distribution and habitat use. It is emphasized that the final configuration of the study area will be determined through a combination of on-site conditions, legal access, and mine layout.

Land ownership in the proposed study area is predominantly private, with smaller amounts of U. S. Forest Service and Bureau of Land Management lands (Figure 3). Negotiation of access onto private lands will be the responsibility of the client. If access is not available in a relatively large tract the shape of the study area may be altered.

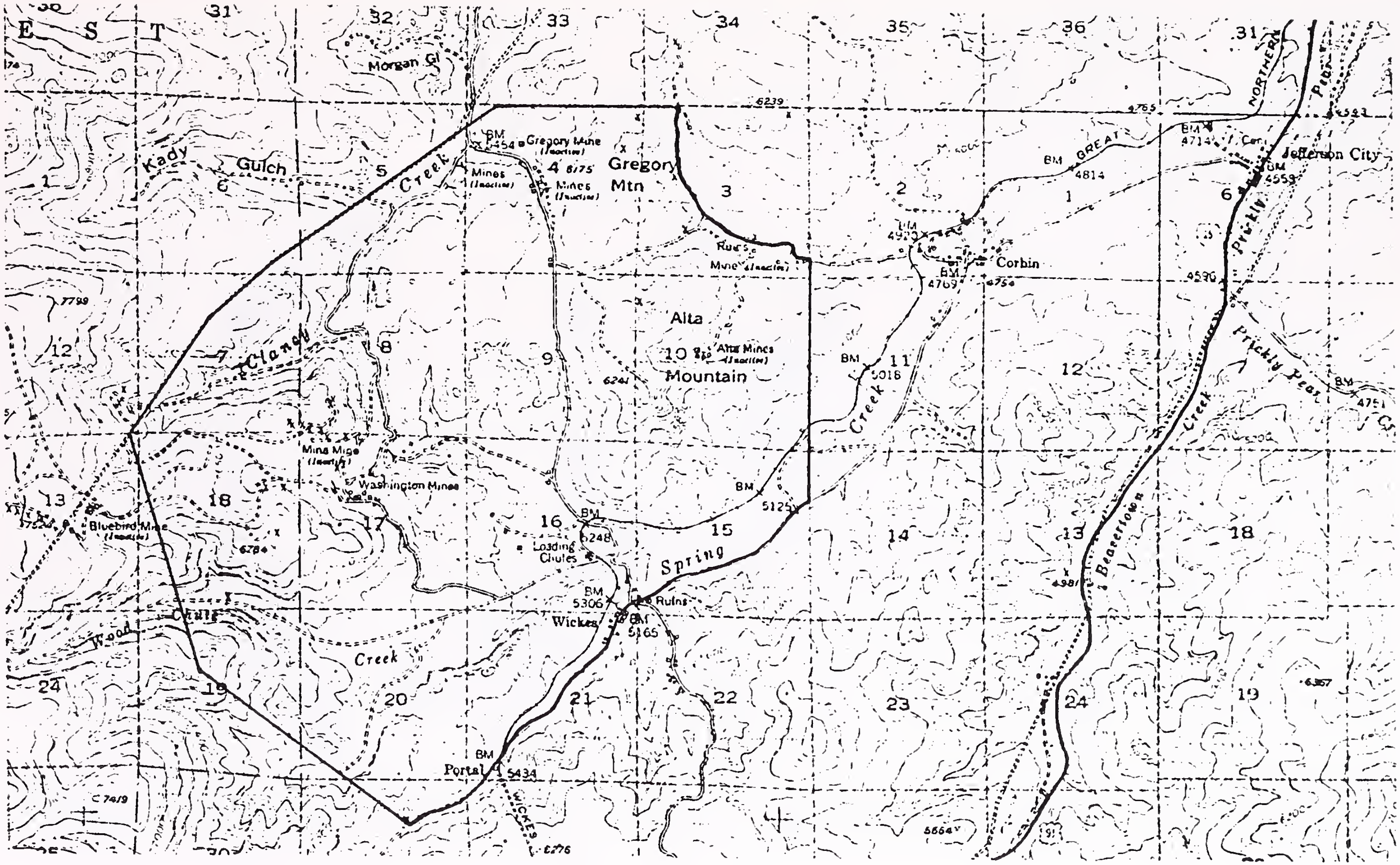


Fig. 2. Proposed wildlife study area, Montana Tunnels project.

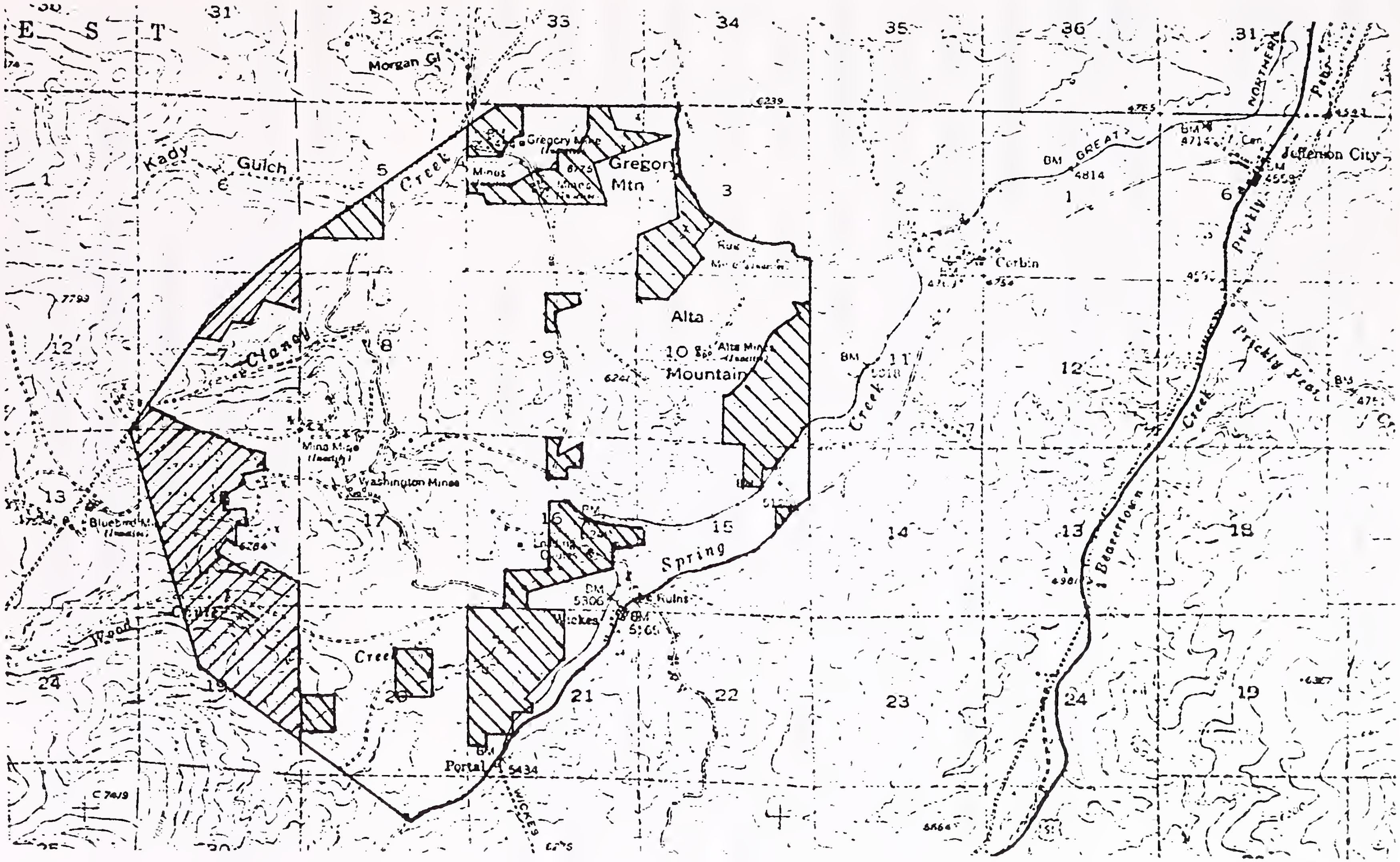


Fig. 3. Approximate land ownership in the proposed Montana Tunnels Wildlife study area. Open is private, right shading is BLM, left shading is U.S. Forest Service.

Study duration will be twelve months (four seasons). The study will begin May 1, 1984. Field work will end April 30, 1985. A final report will be prepared by June 30, 1985.

GENERAL OBSERVATION METHODS

General observation methods provide a considerable amount of distribution and habitat use information. They allow the observer to cover relatively large amounts of area in a small amount of time, and are a standard baseline study technique (States et al., 1978). Disadvantages include observer bias (observability of some species in certain habitats is lower than in other habitats), sampling bias (vehicle routes, for example, can only sample areas where there are roads), and a temporal/spatial bias (all areas cannot be sampled at the same instant in time). Therefore general observation methods must be supplemented by specific methods aimed at major species. Three general observation methods will be used during this study: aerial surveys, vehicle routes, and footpath routes.

Aerial Survey

Six aerial surveys will be flown during the study. One survey will be flown in spring, summer and autumn; three surveys will be conducted during the winter. The primary function of aerial surveys will be to provide big game distribution and habitat use information. A fixed-wing aircraft will be used and will be flown in east-west transect lines

across the area. Transect lines will be about 1/4-mile apart, although some lines will vary in compensation for the mountainous topography. Air speed will be as slow as practical, and altitude will vary between 50 and 300 feet above the ground. All flights will be flown at sunrise, under as ideal weather conditions (clear, no wind) as possible.

All sightings will be mapped on topographic maps and will be recorded by time of day, habitat, species, group size, and age and sex composition (where identifiable). All sightings of major species will also be located on a grid using the Universal Transverse Mercator system.

Aerial surveys may provide accurate distribution data (Caughley, 1977) but seldom provide reliable estimates due to sightability problems related to transect width, aircraft speed and altitude, observer experience and the behavior of the species observed (Caughley, 1974; Beasom, 1979; Miller and Russell, 1977). Depending on the habitat, experienced observers may see only 40-70 percent of the available animals (Beasom, 1979; LeResche and Rausch, 1974; Caughley et al., 1976).

Several methods have been proposed to correct the problem; all are based on estimating the bias involved, rather than attempting to correct the bias and estimate the population (Caughley et al., 1976; Floyd, Mech and Nelson, 1979; and Beasom et al., 1981). For the Montana Tunnels project, the method proposed by Magnuson et al. (1978) may be the most practical.

In this technique, an observer is on the ground at the same time the aerial survey is flown. After the survey is complete, the two observers compare their observations from a given geographic unit. The sightings may be used in the standard Peterson index, where the animals observed during the ground survey are considered "marked" while those from the aerial survey are "recaptures". This method will be attempted at least once during the study. If possible, the method described by Floyd, Mech and Nelson (1982) will also be attempted for purposes of comparison.

Aerial surveys may also be used to determine activity of golden eagle, or other large raptor nests, if those nest locations are known (Hickman, 1972). They may also be used with lesser success to locate such nests, or mated pairs of large raptors.

Vehicle Routes

Vehicle routes will be run along access roads and established trails in the study area. No new roads or trails will be created by this method.

Vehicle routes allow the observer to cover a relatively large area in a short amount of time. Disadvantages include the availability and accessibility of roads through all habitats, low observability in some habitats, and a bias in favor of those animals that frequent roadsides versus those that are displaced from roads. For example, rabbits may be attracted to roads (Farfarman and Whyte, 1979) while elk and deer may avoid them (Rost and Bailey, 1979).

When not precluded by specific study techniques, vehicle surveys will begin about 1/2 hour before sunrise and will be run until completion. Evening surveys will start at a time sufficient to allow completion by darkness.

Observations will be recorded on a standard form and will include (where applicable) date, species, time of observation, habitat, age, sex and activity. Sightings of major species will be mapped on a base topographic map and located with the Universal Mercator System (Colony, 1972).

Footpath Routes

Footpath routes will be walked during the day when other techniques have been completed. The routes will be placed to cover as much of the study area as possible, that is not accessible by road. Routes will be run at least once per month, if possible. A specific path will not be used; rather, a general route through a given part of the study area (with frequent visits to interesting habitat features) will be followed.

Footpath routes will be used to gather miscellaneous information such as observation of tracks, scats, dens or burrows, compiling species lists, random nest searches, habitat mapping, etc. Data will be recorded similar to that from vehicle routes.

SPECIFIC METHODS

Specific methods will be used to obtain data necessary to meet the objectives of the study, that are not supplied by general observation methods.

Literature review

Early in the study the principal investigator will contact the Montana Department of Fish, Wildlife and Parks, U. S. Forest Service and Bureau of Land Management. These agencies will be informed that the terrestrial wildlife inventory is underway, and will be requested to provide access to their wildlife management files and reports from the study area. This information will include big game and upland game harvest information; population estimates; location of winter range, fawning/calving areas, raptor nest sites, etc.; any published reports for the area including management documents, impact assessments, grazing plans, etc.

A list of all terrestrial wildlife species that potentially occur in the area will be developed from general literature sources (Skaar, 1980; Thompson, 1982). Habitat requirements of each species will be tabulated from the results of a review that WESTECH performed for the U. S. Forest Service in 1979. These requirements will then be compared to habitat availability in the area, as this information becomes available.

"Major" species will be selected from the list based on socioeconomic importance, ecological vulnerability or other factors. Detailed literature review will be accomplished for each species with reference to its habitat requirements, sensitivity to disturbance, etc. This list will then be further reduced to those species most relevant to the Montana Tunnels project area.

WESTECH maintains an in-house library that presently contains over 2,200 publications pertaining to terrestrial wildlife. Most of the literature review will be compiled from these publications, supplemented as needed by state and university library materials.

Habitat mapping and analysis

Wildlife habitat types and subtypes will be determined from existing vegetation and physical features. Habitat definitions will be compared to vegetation communities defined by the vegetation inventory. Habitats within sites to be disturbed and an adjacent buffer will be mapped at a scale of 1" = 400'; habitats throughout the rest of the study area will be mapped at a scale of 1:24,000 on U.S.G.S. 7½-minute topographic maps.

As the study progresses, it may be desirable to analyze wildlife sightings (particularly big game) in terms of slope and aspect, as well as vegetation. Slope and aspect will be determined with a compass and clinometer, or by a slope meter (Koeppl, 1979).

It may also be desirable to map the area on a larger scale (e.g. 1" = 24,000') in terms of habitat by individual species (Hawes and Hudson, 1976). In this method, habitat requirements of a given species such as soils, slope and aspect, other physical features, browse availability, etc. would be mapped independently of major vegetation types. Mapped sightings of that species would then be overlain to compare the potential range with known distribution.

Mapped habitat types may also be used in an edge index. Taylor (1977) pointed out that a line transect laid over the habitat map will provide results equivalent to measuring the edge of each mapping unit (Patton, 1975). However, Schuerholz (1974) found that a radial line intercept gave better correlation coefficients than a single line, and that each line in the radial could be shorter than the single line. Such a method could be easily applied as an overlay of the habitat map.

After field work is completed, the number of sightings of a major species by habitat type will be compared to the availability of that type. Use vs. availability will either be expressed as a simple ranking (Johnson, in press) or as a modified chi-square (Neu et al., 1974). This result, when combined with distribution maps, should help describe the value of certain habitats.

Browse utilization

Cole's (1959) method has been a standard technique in Montana for some

time, but has been criticized (Mackie and Lonner, 1977) for sampling effort, observer differences in interpretation, changes in browse use from year to year, and even the premises on which it is based. It has been recommended that this method be discontinued.

However, knowledge of relative use of browse by big game and/or livestock may be valuable in determining revegetation recommendations. The following method is proposed to meet this objective:

a. Browse transects will be located throughout the study area and near the project disturbance area. Transects will be run in spring only. Five transects will be set out in each site.

b. Each transect will consist of a 50 m line intercept (Canfield, 1941) to measure coverage and frequency of each shrub species. In addition, all shrubs within one meter of each side of the transect will be identified and counted. Thus, shrub frequency and density will be determined in a 100 m^2 strip transect. Constancy between transect sites will be compared.

c. All shrubs of a given species in the strip transect will be examined for whether or not they have been browsed. Plants will be grouped as browsed or unbrowsed. Quantitative estimations of browsing intensity will not be attempted, although the observer may subjectively note browse use on the field form.

d. Browse use will be determined by two methods. First, the observed number of browsed plants will be compared to the expected number (chi-square) determined from the transect. Secondly, if coverage of two morphologically similar species (e.g. big sagebrush and bitterbrush) varies significantly when compared to their expected densities, it may be due to a differential preference in browsing rates.

e. If the above methods provide results that differ dramatically from the subjective evaluation of browsing intensity in item c, five plants of a given species will be randomly selected from the strip transect. The number of browsed vs. unbrowsed twigs on each plant will be counted, then compared to the results of item d.

Pellet group counts

Pellet group counts have often been used to compare ungulate use of various habitats by season (Thompson, 1955; Julander, 1955; Rogers et al., 1958). In some cases, pellet group counts have been used to estimate populations, (Neff, 1968), particularly when the number of pellet groups deposited per day, or the number of pellets per group (Strong and Freedy, 1979) is known. However, White and Eberhardt (1980) demonstrated that plot pellet group counts are best used as long-term indices of deer trends.

For the purposes of the Montana Tunnels study, pellet group counts are

intended to supplement observations of ungulate distribution and habitat use, rather than to estimate populations. Pellet group counts will be run along a pedestrian route, rather than in plots. The method to be used was adapted from Lonner (1975). The observer will walk the route, counting the number of pellet groups observed and the number of paces taken in each habitat type. A PG/pace/type value can then be calculated. Counts will be run in autumn and spring; age of pellet groups will be subjectively differentiated as old (prior to the current season) or recent (within the current season).

It may be impossible to differentiate between pellet groups of elk and mule deer. Several studies have shown that fecal pH is the most reliable parameter to separate species (Howard and Delorenzo, 1974; Krausman et al., 1974; Hansen, 1978; Peek and Keay, 1979) but this analysis is not suitable for the proposed technique. If elk and deer pellet groups are not easily separable, they will be lumped for analysis and it is assumed that sightings from other methods will provide general distribution information. Moose pellet groups will be considered separately.

Small mammal trapping

Small mammals will be trapped to document the potential species list and to differentiate species use of major habitats.

Snap traplines will be placed in as many habitats as possible, in sites to be affected by mining and in adjacent undisturbed areas. Trapline

locations will be chosen in the spring and summer, and trapping will be done in late summer and autumn. Each trapline will consist of 24 mouse traps, placed in line with 5 or 10 m intervals between traps. A rat trap will be placed as the 25th trap. Pitfall traps may be used in some transects to catch shrews. Every rodent killed will be identified. Age will be determined from weight and pelage, and sex will be estimated from external characters.

Breeding bird surveys

For the purpose of this proposal, breeding birds are considered all species except raptors.

There are probably only two species of upland game birds present in the area (Mussehl et al., 1971). Blue grouse may be found in most of the coniferous/shrub edges in the study area. They will be surveyed in spring by listening for displaying males during vehicle routes, and by observing birds along vehicle and footpath routes (Mussehl and Schladweiler, 1969). Ruffed grouse primarily inhabit the creek bottom complex and will be indexed in spring by listening for drumming males.

Non-game breeding birds in forest habitats will be censused with point transects (Mikol et al., 1979). The observer will stop every 200 m along a 1000 m transect. All birds seen or heard within five minutes at each stop will be recorded.

In open habitats, Emlen's (1971) flush transects will be used. The observer will walk a 1000 m transect, recording all birds seen or heard. Approximate width of the transect will be estimated for each species. Data from each method will be analyzed as the kind and number of birds observed in each habitat (index), and as the density of certain species in each habitat. In forested types, subjective evaluations of the use of the vertical habitat (Manuwal, 1966) will be made.

Raptors

The proposed mine permit area will be intensively searched for active and inactive nests. In the remainder of the study area, active nests will be located by observing territorial birds, by listening for territorial owls, or by random searches along footpath routes.

Once a nest is located, it will be photographed, mapped on a base topographic map, and described in detailed field notes. Active nests will be periodically visited to monitor fledgling success, but will not be disturbed. After the nesting season, nests will be visited and prey remains will be collected and identified.

Throughout the study period, all raptor observations will be mapped on a base topographic map and will be described by habitat type and activity of the bird. It may be possible to combine mapped sightings to reveal hunting territories or preferred habitats/areas of activity.

Reptiles and amphibians

No systematic searches for reptiles and amphibians are proposed. Any herptiles observed during any other methods will be identified and described by habitat.

Threatened or endangered species

It is not likely that any Federally listed threatened or endangered species will occur in or near the Montana Tunnels project area. The two species most likely to be observed are the endangered bald eagle and peregrine falcon, both of which may migrate through the area.

Any sightings of threatened or endangered species will be mapped and recorded. If these sightings suggest more than incidental occurrence they will be reported immediately to the proper regulatory agencies. Otherwise the sightings will be described in the final report.

Human activity

Pre-mining human activity in the study area includes recreation, residential and limited industrial actions. The effect of this activity on wildlife distribution, habitat use, numbers, etc. has not been addressed. Since one of the major impacts of mining development will likely be the increase in human population in the study area, a pre-mining data base would be beneficial for estimating or comparing impacts.

The following steps are proposed to analyze human impacts to wildlife. Data would be collected by the field biologists during normal wildlife survey schedules:

a. Data on human group size, activity, distance from roads, etc. would be recorded on a field form (see Appendix) while the biologist is performing other duties.

b. Human concentration areas (campsites roads, building areas, etc.) will be compared to distribution of major wildlife species during identical time periods.

c. Human/wildlife interaction literature will be reviewed, particularly for those studies involving telemetered animals.

It is recognized that visual observation of human/wildlife activity includes several biases, such as: 1) since wildlife data collection in this study relies on visual location, the field biologist is essentially a component of the human activity variable to be measured; 2) it is recognized that observations of human activity will be more readily made and recorded than those of certain wildlife species, and that results will favor those species or individuals that adapt to human presence; 3) as with other general observation methods, data collection is limited to those areas visited by the field biologist; 4) in data analysis, it may be difficult to separate effects of human activity from other

seasonal changes in wildlife use patterns. Although this proposed monitoring plan contains these biases, it is believed that the data combined with the results of the baseline socio-economic survey, will provide a deductive representation of pre-mining conditions.

Miscellaneous

No specific methods are proposed for species such as coyotes, bobcats, mountain lions or furbearers. Sightings of these species or their evidence will be recorded. If it becomes apparent that substantial numbers of a given species are present in the area, specific techniques may be applied to index their populations.

Snow depths and the strength of its crust will be measured with a penetrometer during the 1984-1985 winter. Measurement locations will be determined by the winter distribution of ungulates in the area, while sampling frequency will be regulated by winter conditions.

DATA PRESENTATION

Results of the study will be presented in a single report, written after field work is completed. Methods will be explained in detail. Results will be presented by major species or groups of species e.g. elk, mule deer, raptors, breeding birds, etc. Distribution maps will be prepared for major species. For big game, these maps will be by season. For raptors, maps will show nest locations.

Other results, such as habitat use, population estimates, etc. will be explained in detail. Photos (35 mm prints) of representative habitats and important features will be included, as will the final wildlife habitat map.

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VEGETATION/AGRICULTURE

The vegetation/agriculture portion of an application for operating permit is generally not critical in DSL's decision-making process. Its importance lies in providing information for the reclamation plan (post-operation land use and seeding mixtures) and in DSL's preparation of a Preliminary Environmental Review (PER) or Environmental Impact Statement (EIS). Vegetation may be important if threatened or endangered species are encountered, however, it is unlikely that such plant species occur in this area of Montana. DSL has exercised a wide range of requirements for baseline vegetation inventories and the scope of work should be reviewed with DSL prior to implementation of field work. The following scope of work is based on our experience in dealing with DSL on similar projects.

LITERATURE REVIEW

Available literature for the study area will be reviewed and summarized. Sources will include the U.S.D.A. Forest Service, U.S.D.I. Bureau of Land Management, Montana Department of Fish, Wildlife and Parks, Montana Department of State Lands, scientific journals, student theses and unpublished information from our files. The BLM manages a few small parcels of land in the area; although the Forest Service has no land directly involved, the Helena National Forest lies adjacent to the west of the project area. WESTECH's comprehensive library contains the majority of publications dealing with Montana's vegetation.

COMMUNITY TYPE MAPPING

The proposed permit area and a 400-foot buffer zone will be mapped on existing aerial photographs or topographic maps (1"=400'). Community types will be based on existing species coverage or potential plant assocations, where identifiable. Preliminary mapping units will be field-checked using foot and vehicle traverses. Final type names will reflect dominant species from the canopy cover transects or, where appropriate, will follow the classifications of Pfister et al. (1977) for forested habitat types and Mueggler and Stewart (1980) for grassland and shrubland habitat types. All identifiable mapping units over two acres will be delineated.

FIELD INVENTORY

Transects will be dispersed throughout the study area to avoid oversampling in a particular locale and to obtain at least two samples of each community or habitat type. Types which occupy a greater areal percentage of the study area will be correspondingly more intensively sampled than minor types. The following allotment of field inventory effort is based on familiarity with types present on the study area, in conjunction with site reconnaissances recently conducted. Approximately eleven types currently occupying the study area will be quantitatively sampled. Forested areas are dominated by ponderosa pine or Douglas fir. One or two ponderosa pine habitat types will be found at lower elevations and on south aspects at higher elevations. Two or three Douglas fir habitat types occupy the majority of forested slopes

in the study area. Stands of quaking aspen occur on moist microsites. Three tentatively identified shrubland types include bitterbrush/bluebunch wheatgrass, horsebrush/bluebunch wheatgrass/prairie junegrass (degraded sere) and mesic shrub draw. Two tentatively identified grassland types, bluebunch wheatgrass/prairie junegrass on shallow soils and rough fescue/Idaho fescue on deeper soils, both reflect past grazing in community composition. Two other types which will be qualitatively assessed and mapped are agricultural (hay meadows) and areas historically disturbed by mining.

Since the principal investigators are very familiar with vegetation of the study area, it is estimated that each two-person crew can complete all field inventory tasks (collection of cover, production and forest stand data) at a rate of 2-2.5 transects per day, allowing for travel time. The two crews will therefore complete 40-50 transects in a ten-day work period in early August.

Canopy cover and frequency

Canopy cover and frequency will be sampled using a system modified from Daubenmire (1959). Each community type will be sampled, except types occupying two acres or less. Transects will not be permanently located. A 50-meter fiberglass tape will be layed out along the terrain contour with 20 2x5 dm rectangular plots established at two-meter intervals on alternating sides of the tape. Cover values for all vascular plant species, bare ground, rock, litter, lichens and moss will be estimated

to the nearest percent. Slope, aspect and general soil type will be recorded for each transect. Photographs will be taken of each transect.

Production

Production transects will be established two meters to the right of and parallel to the canopy cover lines with plots spaced at 15 meter intervals (15, 30, and 45 meters). Understory production data will not be collected in dense stands of timber. Three $1/2m^2$ plots will be clipped to ground level with clipped material bagged separately for each plot and all material separated into the following groups:

grasses and sedges
forbs
subshrubs
shrubs

All material will be oven dried at 70°C for 48 hours and weighed to the nearest 0.1 gram. Laboratory work will be conducted in-house using our drying oven and Ohaus 1500 top-loading electronic balance.

Forest data

All transects located in forest stands will be sampled to obtain data on age, dbh, height, stocking and basal area. The point-center-quarter method will be used (Oosting, 1956). Age will be estimated by counting growth rings on five mm diameter tree cores. A diameter tape will be used to measure diameter at breast height. Height will be estimated

for shorter trees and measured by triangulation with an Abney hand level for taller trees.

RANGE SITE MAP/CONDITION AND TREND

A range site map (1"=400') will be prepared for areas qualifying as rangeland. Condition and trend will be qualitatively measured using guidelines of the U.S.D.A. Soil Conservation Service or U.S.D.A. Forest Service in conjunction with site production data. A soils map is a prerequisite to completion of this task.

SPECIES LIST

A complete species list will be prepared for the permit area. The field crew's familiarity with site flora will greatly facilitate this task. Early-blooming flora will be collected prior to the field inventory in order to facilitate 1) preparation of the species list, 2) the search for rare and endangered species, and 3) the collection of quantitative data during the field inventory. Three one-day site visits would be optimal, in early May, early June and early July. Species not readily identified in the field will be collected and later identified using a stereozoom dissecting microscope. The primary taxonomic references will be Booth and Wright (1966), Hahn (1977), and Hitchcock et al. (1955-1969); nomenclature will generally follow the latter reference. A thorough search will be conducted to locate plant species listed as rare or endangered by federal or state agencies, with special reference to the listing by Montana Rare Plant Project (1984).

BASELINE REPORT PREPARATION

Community type descriptions and data summaries will be tabulated and narrated in a baseline report on existing vegetation resources of the project area, following DSL guidelines.

SUMMARIZATION OF BASELINE REPORT

The vegetation baseline report will be summarized in a manner suitable for inclusion in the Environmental Information section of the permit application.

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GEOLOGY

A description of the geological setting in the mining and ore processing area will be developed. A geological map will be prepared that will show surficial geology and structure of the area, including fault zones and areas of geological hazards such as rockslides or landslides. A geological history of the area will be included, including mineralization in the area that has resulted in the ore body. The general mineralology, lithology and chemical nature of the ore and waste rock will be described. This discussion will also include a discussion of other potentially economical mineral resources in the Montana Tunnels area. If there are any unique geological features in the area, these also will be described.

SOILS

The soils survey of the project area will encompass several hundred acres in moderately steep to rolling hills and bottom lands. Prior to initiation of field work, the USDA Soil Conservation Service (SCS), the USDI Bureau of Land Management (BLM) and the U. S. Forest Service will be contacted to determine if soils-related information is available. Any soil survey or other soils information assembled will be transferred to a project map of a scale of approximately 1:4800 (1" = 400'). Following compilation of existing information, field work will commence. Stereo aerial photographs (1:12,000 or larger scale) and a suitable scale base map are necessary for the soils survey work.

Primary objectives of the premining inventory will be:

1) Delineate the location and extent of the different kinds of soils occurring within the area which may be disturbed by mining or other mechanical operations or that have been previously disturbed.

2) Sample and conduct laboratory analysis of soils which will be affected by the proposed mining and milling operation.

3) Identify soils suitable for reclamation.

4) Identify problem soils with respect to reclamation including occurrence of metals or other chemical imbalances, limited water-holding capacity and susceptibility to erosion.

Objectives one and two will aid in evaluating the suitability of various soils for reclamation purposes by determining the depth to which they can satisfactorily be salvaged for use as topsoiling materials. Knowing depth and areal extent, an estimate will be made of the total volume of suitable topsoiling material available for salvage. Identification of problem soils will allow the impacts of the mining plan, including roads and ancillary facilities construction, to be assessed and will provide information necessary for planning appropriate reclamation procedures. Existing cuts and trenches will be used to obtain soil profile information and samples in many areas. Hand-dug pits will be used where no cuts or trenches exist.

Study Tasks

1) Field Studies: The soil study will be done on the project area. It will be conducted on a detailed basis on a map scale of 1:4800 (1 inch = 400 feet) or larger scale. Classification and mapping will be done primarily by individual soil series and phases. Soil complexes will be designated only when the soils comprising a mapping unit are in such small bodies and are so intricately associated that separation of the individual components is not possible or is not feasible. Classification, mapping, nomenclature and all other facets will be in accordance with the National Cooperative Soil Survey of the U. S. Department of Agriculture.

Some of the area has been disturbed by previous mining activities; however, the soil investigation will concentrate primarily on undisturbed sites and provide adequate information for development of a reclamation plan. An Order I survey will be conducted for undisturbed areas within the proposed disturbance boundary; an Order III survey will be conducted of the proposed permit area, including previously disturbed materials.

Guidelines listed below will be followed as closely as possible:

a) Soils of high contrast

Bodies of soils that differ markedly in physical and/or chemical properties from adjoining soils and are two acres or larger in size will be delineated. Easily defined bodies of these kinds of soils having boundary limits less than the above stated size will be mapped separately, whenever possible.

b) Soils of low contrast

Bodies of soils that differ only slightly in physical and/or chemical properties from adjoining soils and are five acres or larger will be delineated.

Very shallow or shallow soils, those soils containing a high percentage of rock fragments and those soils on 50 percent

or more slope may not need to be sampled for laboratory analyses but will have a detailed pedon description.

Samples will be collected from representative soils intended for use in the final reclamation plan. Sampling will be to a depth adequate to identify major soil horizons and characteristics important to reclamation or to bedrock, whichever is shallower. Representative samples will be collected from each genetic horizon or contrasting subhorizon or from each layer, from the surface down. Any surface or subsurface horizons or layers less than three inches (8 cm) thick will not be sampled separately, except for the A horizon, but will be combined with part or all of an adjacent horizon or layer in sampling. Duplicate samples of approximately one half kilogram (one pound) will be collected from each horizon or layer sampled.

All soil samples will be accompanied by a detailed description of the pedon. These descriptions shall be in accordance with the standards developed for use in the SCS soil survey program.

Sample sites will be located by legal description and will be shown on the soil map.

2) Laboratory Analysis, Report Preparation and Mapping: Each sample will be analyzed in accordance with accepted or modified laboratory standards and procedures. The following analyses will be conducted:

pH

Calcium, Magnesium and Sodium (Water Soluble Extract)

Sodium Absorption Ratio (SAR)

Boron (ppm)

Partical size determination (percentages of sand coarser than very fine sand, fine sand, silt and clay)

Calciumn carbonate equivalents

Nutrients N, P and K

Agricultural lime requirement

In addition, selected tailings and potential borrow area soils will be analyzed for the following metals:

Zinc

Copper

Lead

Manganese

Arsenic

A soil map based on aerial photographs will be prepared at appropriate scale for the project. It will clearly show all mapping unit boundaries, their assigned symbols and an appropriate legend.

The soil survey report will accompany the soils map. It will consist of:

a) A list of the map symbols with soil names. If the series are assigned names for identification or reference purposes, a statement will be inserted in the soils report indicating that the names have no official status;

b) A description of the pedon most representative of each soil series and its range in characteristics; and

c) A description of each mapping unit. As a minimum, a mapping unit description will include the following:

    1) The kinds of soils -- both major and minor;

    2) An estimate of the percentage composition of these soils in the unit;

    3) The position or occurrence of both the major and minor soils within the landscape;

    4) The nature of the relief and/or topography;

    5) The range of slope gradient upon which the unit occurs, and

    6) A brief statement indicating whether the soils represent the series as defined by the SCS. Any additional information that will document the

characteristics of the soil can be added to these descriptions.

d) A detailed description of the reclamation characteristics and management implications for each mapping unit.

LAND USE

Present land uses in and adjacent to the proposed mining and mineral processing areas will be described. It is anticipated that major land uses in the area will be for mining, timber production, grazing and, to a much lesser extent, crop production. General land ownership in the area also will be described.

ENERGY

A discussion will be prepared discussing existing power corridors in the area and the proposed source of power for the mining and mineral processing facilities. This will include a discussion of portable generators, if needed on the project, or any other generating facilities that may be used on site to supply power to the project area.

TRANSPORTATION

The exising road network in the area is the only transportation system. There is an abandoned rail line not far from the project but the entire project is served only by roads which vary from small jeep trails to graded all-weather roads.

AESTHETICS

The aesthetics and visual resources of the area will be described to provide an understanding of how the visual resources of the area will be modified. The visual resources will include a description of changes in shape, form, line, contrast and texture and will relate these to view distances and contrasts with foreground and background views for persons that are traveling major roads in the area.

NOISE LEVELS

Predicted noise levels of operating equipment in the mine and ore processing area will be described and effects on existing noise levels in nearby areas will be considered. There are no schools, hospitals, libraries or other public buildings in the area. The only residential areas are those in Corbin and Wickes and isolated summer cabins in the general area.

SOCIOECONOMIC HUMAN ENVIRONMENT

The study area for the socioeconomic baseline assessment will consist of Jefferson and Lewis and Clark Counties, the municipalities of Helena and Boulder, school and special districts within approximately 20 miles of the project site (i.e., Boulder to Helena). While the proposed mine site is in Jefferson County, most available housing and the preponderance of medical, governmental and commercial services are located in Lewis and Clark County. The baseline study will not include Silver Bow County (Butte), about 50 miles south of the mine site, although that area may supply commuting mine workers for the project. The study can be expanded to cover that location, if necessary.

Study Elements

Data collection for the baseline socioeconomic assessment will be organized to follow the Montana Department of State Lands (DSL) Plan of Operations Guidelines. The guidelines identify ten topic area, including:

1) Social Structure: Cultural Uniqueness/Diversity
2) Population: Quantity and Distribution
3) Housing: Quantity and Distribution
4) Human Health and Safety
5) Community and Personal Income
6) Community and Personal Income
7) Tax Base: Local and State Tax Revenue

8) Demand on Governmental Services
9) Industrial and Commercial Services
10) Local and Regional Environmental Plans and Goals

Each topic area will constitute a section or chapter in the baseline study report. Within each chapter, the information will be organized around three basic elements.

1) Historical background information will be compiled to show the trend of social/economic evaluation from 1970 to present.

2) A series of baseline projections will be developed to show what is likely to occur in each topic area without the advent of the Montana Tunnels Project. The baseline projections will serve as the base for the impact assessments.

3) A series of impact projections will be developed to specify the degree of socioeconomic change the area is likely to experience as a result of mine development. The analysis also will describe the project area's general ability to accommodate any socioeconomic change created by mining.

Three of DSL's topic areas (i.e., housing, human health and governmental services) will be analysed concurrently as part of an overall

assessment of services in the project area. Eleven basic service categories will be examined, including:

1) Elementary/Secondary Education
2) Law Enforcement
3) Fire Protection
4) Water Supply
5) Sewage Disposal (wastewater)
6) Solid Waste Disposal
7) Transportation, Highways and Roads
8) Recreation
9) Housing
10) Medical Services
11) Utilities

Each service category will be assessed in terms of its existing capacity and condition and, hence, its basic ability to absorb potential demand created by the onset of mining in the area. Within the housing assessment, a housing real estate inventory also will be compiled for the Boulder area, the Jefferson City-Montana City region and the Helena and Helena Valley area. The location of housing is pivotal with respect to the demand for other governmental services.

The public finance analysis will detail patterns of public expenditure, revenues and taxation for the two counties, any affected municipal-

ities, school districts and special districts. Comprehensive background data is essential in this task element since it feeds the revenue/expenditure estimates used in the HB 718 plan to measure what financial obligation, if any, the developer will face to mitigate socioeconomic problems.

CULTURAL RESOURCES

INTRODUCTION

This scope-of-work describes the proposed inventory of lands which will be directly impacted by the Montana Tunnels project. This involves an area of 1000-1500 acres. A slightly larger area around the actual areas of disturbance will be inventoried to provide a "buffer zone" for potential changes in project design. The cultural resource study will provide baseline information of sufficient detail to enable the preparation of an Environmental Impact Statement (EIS) as required by state and federal laws.

The proposed inventory will be conducted by Lynn Fredlund (principal investigator), and Paul Anderson (historian). The Bureau of Land Management - Butte District (BLM) and the State Historic Preservation Office (SHPO) will be consulted when and as appropriate.

The objectives are to:

- Locate and record cultural resource sites within the areas of direct potential impact,
- Define and evaluate known heritage sites within the impact area,
- Evaluate the significance of the cultural resources in terms of their eligibility to the National Register of Historic Places,

0 Assess the impact of the proposed development, both direct and indirect, upon those resources and to propose mitigation procedures in consideration of the impacts and the significance assessments.

TASKS

The various tasks are designed to provide adequate documentation to allow the State Historic Preservation Office and the Montana Department of State Lands (MDSL) to properly assess the significance of the sites and features, and to determine the effects on these resources by the proposed mine development. The work will satisfy federal requirements as well.

Task 1. Collect and Evaluate Existing Data

This task involves a comprehensive review of all literature and files pertinent to the archeological, historical and ethnographic background for the project area. A literature/records search of alternative tailings ponds, etc. can also be conducted at this time. The information gathered will describe the known cultural environment and will form the baseline information for determination of the significance of sites recorded. Previous cultural resource inventory work in the general area of the project has been conducted by Historic Research Associates and the BLM. Duplication of effort will be avoided. The following specific background material will be covered:

1. a review of the literature,
2. a records search for sites within the project area,
3. a check for sites on the National Register of Historic Places,
4. a review of the GLO plats, and
5. oral interviews to determine the locations of several reported sites and one known burial in the area as well as any other information relevant to the history of the area.

The records search will include a search of the state master files at the University of Montana, and a search of BLM cultural inventory files. A list of sites on the National Register of Historic Places, and those in the process of eligibility determination will be requested from the SHPO. Amateur and professional archeologists who are familiar with the project area will also be consulted. County historical societies and local historical informants will be contacted during the course of the project. The work will be conducted by the principal investigator/project director and the project historian prior to the fieldwork.

Task 2. Level III Inventory

Definition of Sites: Cultural resources are remnants of past cultures and societies. They are resources in that they provide links between the present and the ephemeral past. Artifacts and locations provide the tangible evidence. Cultural resources are generally regarded as

falling into one of three categories: historic, prehistoric or paleontological. Historic resources are those items and sites (locations) older than fifty years and originating after Anglo colonization of the Americas. Prehistoric resources are those items and sites relative to the Amerindian populations and originating prior to Anglo colonization. Paleontological resources are those biological specimens and sources relating to the early development of the Earth's history. A cultural heritage site is an area which exhibits evidence of past cultural behavior. It is through the study of such sites, and the data contained within them, that the story of the past history of a particular region can be developed.

Field Examination Methods and Techniques: Field coverage is designed to be of such intensity to locate all sites with surface indications and subsurface sites through limited testing. All areas of potential cultural occupation or activity will be covered by surveyors walking the ground at no greater than 30 m intervals. Testing will be limited to shovel probes generally no greater than 50 cm x 50 cm. All soil from the tests will be screened through a mesh no greater than 6.3 mm (0.25 in). These tests will be placed on sites and at locations which appear to be likely prehistoric camping localities. Testing will be to 1) determine the presence of artifacts, and 2) establish the limits of a site. Slopes exceeding 30° will not be traversed but will be visually

scanned for rockshelters and for evidence of historic activity (mine adits, etc.). Sites located by the survey team are briefly recorded. The project director will conduct the final mapping, recording, testing, and assessment.

Site Recording Procedures: Standard State of Montana site inventory forms will be prepared. The project director and an assistant will conduct the site testing, conduct the collection of formally prepared tools, establish a semi-permanent datum (e.g., rebar with survcaps, small rock cairn or other means), subjectively assess the material types present, shovel test and screen, photograph, and sketch map each site. Sketch maps of sites will be made using a Brunton transit system. The maps will be in sufficient detail to provide 1 or 2 m contour intervals. Historic sites will be recorded by the project historian.

Collection of artifacts will be limited to diagnostic or patterned tools and each will be noted on the sketch map as to its location from datum. Each tool collected will be catalogued. Measurements and detailed examination of the tool will be conducted in the lab and this information added to the site inventory form.

Testing: All prehistoric sites and historic locations with the possibility of yielding prehistoric or significant historic materials

will be tested. The objective of testing is to 1) help determine the eligibility of a site and 2) to gather enough information to prepare a mitigation plan, if warranted. The number and depth of tests necessary will be determined by the project director on a site by site basis. Depth of tests will be sufficient to assess the presence/absence of subsurface cultural materials.

Laboratory Analysis and Site Assessment: Based on the collected data, laboratory analysis and research, and literature review, the sites will be asssessed in terms of their eligibility for the National Register. Historic sites will be evaluated by a historian and prehistoric sites by an archeologist familiar with western Montana prehistory. If additional data are necessary for significance determinations, recommendations for further work will be made.

Laboratory analysis provides the initial framework by which a site can be properly evaluated, interpreted and assessed. Most analysis can be conducted by in-house personnel; on occasion more detailed analysis is necessary, requiring the expertise of specialists.

Cultural Resource Assessments: Significance assessments are a crucial element of the legal responsibilities of consulting archeologists, and

state and federal agencies charged with the care of cultural resource sites and materials. They are also critical to the formulation of reasonable and responsible management plans. The principal investigator will assist the project director in the significance assessments. Fred Quivik, architectural historian, will assist the GCM historian in architectural assessments.

These assessments are made by evaluating each site in respect to the 10 National Register Criteria (35 CFR 800:10). A site is assessed as being significant and therefore eligible for inclusion on the National Register of Historic Places if it has:

1. Integrity of location,
2. Integrity of design,
3. Integrity of setting,
4. Integrity of material,
5. Integrity of workmanship, and
6. Integrity of association;

   and/or if the site exhibits:

7. Association with a broad pattern of historical events,
8. Association with significant persons, or
9. Embodies distinctive characteristics of a type, period, or method of construction, or
10. Has yielded or may be likely to yield information important in prehistory or history.

Criteria 1 through 9 were written with historic buildings in mind, and consequently some stretching is required in order to find a meaningful way to apply them to prehistoric sites. On the Northwestern Plains most prehistoric sites are notable only for the information they contain. This information is usually in the form of lithics, floral or faunal remains, and various features (e.g., hearths, stone boiling pits, stone circles). For this reason the majority of sites will be assessed mostly in terms of the tenth criterion.

Historic sites are generally assessed by all 10 criteria, or at least as many as seem applicable to the specific case. It should be noted, though, that historic sites also may be significant only for the information they contain. Of primary consideration is that the site should be more than 50 years old and that it retains a minimal physical integrity.

In specific regards to this project, a historic mine complex present in the project area should be sufficiently intact to visualize the original appearance of the mine and to be able to discern the basic processes of the mining operation. If physical remains are present, a historic mining site could also be eligible if a significant component of the mine was a unique technological or engineering development. Finally, a site would be eligible if a significant historical event occurred at the mine or if a locally or regionally significant person was involved in the operations.

Task 3. Technical Report

The Technical Report will detail all information collected on the project, provide tabular data where appropriate, summarize in narrative form each site recorded, include information on the impacts and their probable effects, and make recommendations for management planning. The report style will follow the guidelines established by the Society of American Archeology, the National Register of Historic Places and accepted by the state and federal reviewing agencies.

Task 4. Meetings with Agencies

Three meetings with the agencies and the company are anticipated for this project. The first will be to define the scope of work, prior to initiation of Task 2. The second meeting will be with Hydrometrics after the fieldwork is completed to discuss the results, problems and constraints. The final meeting will be with the DSL, SHPO, and company representatives after agency review of the report. This meeting will discuss the work, recommendations by agency and SHPO personnel, impacts, NRHP recommendations, and mitigation measures.

Task 5. Mitigation Plans

After review of the final report by Hydrometrics, Inc., Centennial Minerals Ltd., and the respective agencies, National Register forms can be prepared for any sites recommended as eligible. These will

be submitted by the agency to the Keeper of the National Register in Washington.

At this time, a meeting (noted in Task 4) will be held to discuss the proposed impacts and possible mitigation measures. The mitigation plan will be developed in coordination with DSL, SHPO and the company and will describe in detail the research goals to be addressed, the information to be collected, and the extent of work to be conducted. The type and extent of the impact will be taken into consideration in the mitigation plan.

The primary and generally most desirable means of mitigation is avoidance. Re-routing roads or transmission line corridors is an option. Alternative siting is another option. In the event that avoidance is not viable, mitigation by excavation, further research, oral interviews or other means can be devised.

RELATIONSHIP WITH OPERATING AND RECLAMATION PLANS

The baseline environmental studies will provide information needed to develop a comprehensive operating plan for the mining and ore processing operation and to develop a reclamation plan for restoration of the area after completion of mining and ore processing. Any other studies will provide direct input for the operating plan and can be used to design the entire operation to minimize impacts of the operation on the areas resources. The baseline information also will be important in design of the reclamation plan, including the use of subsoils and topsoils in the reclaimed area, revegetation and restoration of hydrological systems.

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ORGANIZATION AND MANAGEMENT

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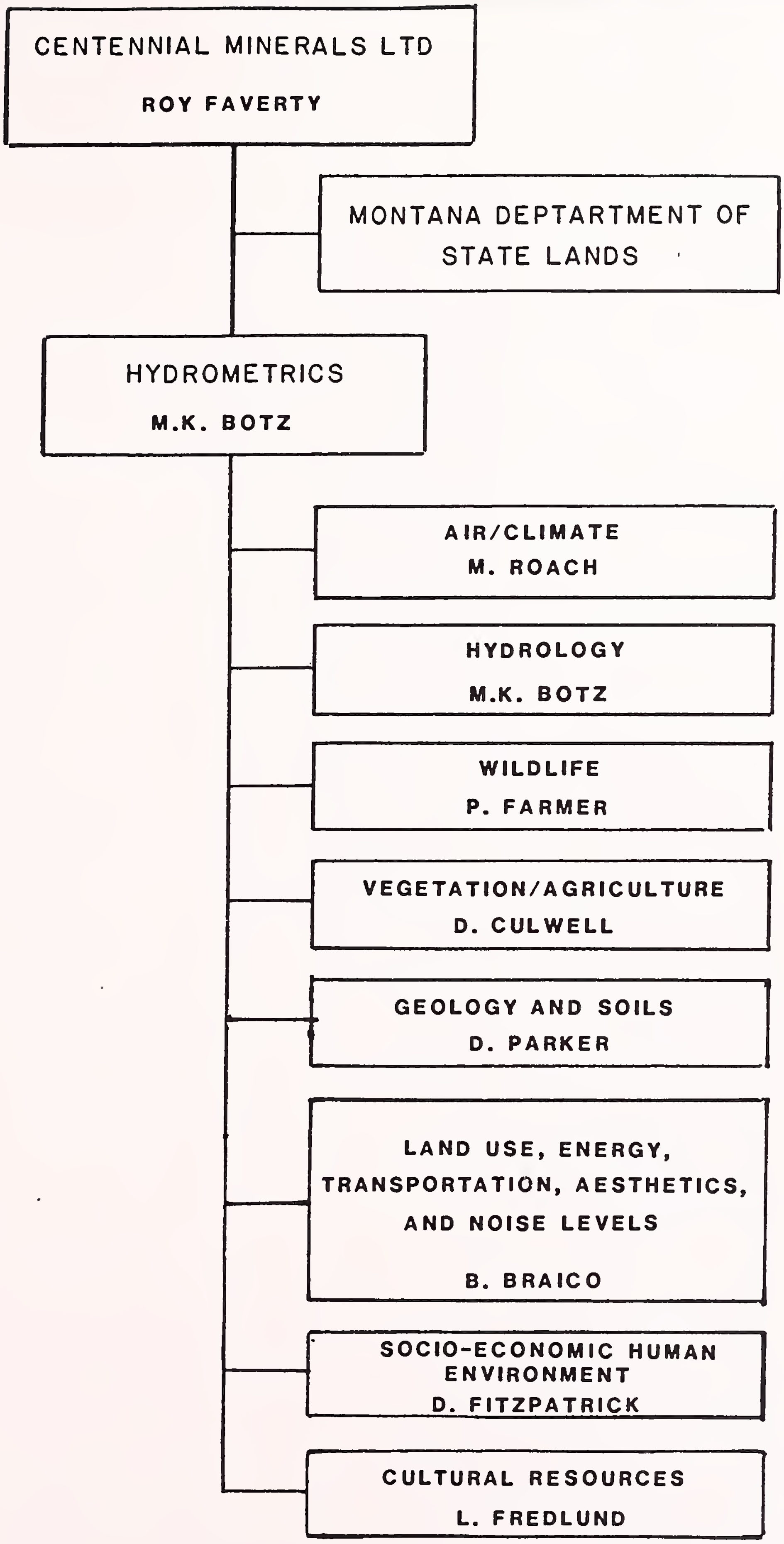
All persons involved in the environmental baseline studies are qualified professionals and are experienced in hard rock mining projects in Montana. The environmental baseline study will be under the administration of Mr. Roy Faverty of Centennial Minerals, Ltd. and will be managed by M. K. Botz of Hydrometrics. Mr. Botz has over twenty years of experience in conducting and directing technical investigations of proposed and existing hard rock mines in the western United States. Mr. Botz will be responsible for project management, including definition of the scope of work needed for each technical discipline and coordination with Centennial Minerals, Ltd. Mr. Bob Braico of Hydrometrics will be the assistant project manager and will handle the day-to-day coordination and contacts between Hydrometrics and other consultants. Mr. Braico has over ten years of professional experience conducting and directing interdisciplinary investigations, including preparation of applications for DSL operating permits for hard rock mines using a mill and cyanide for gold extraction.

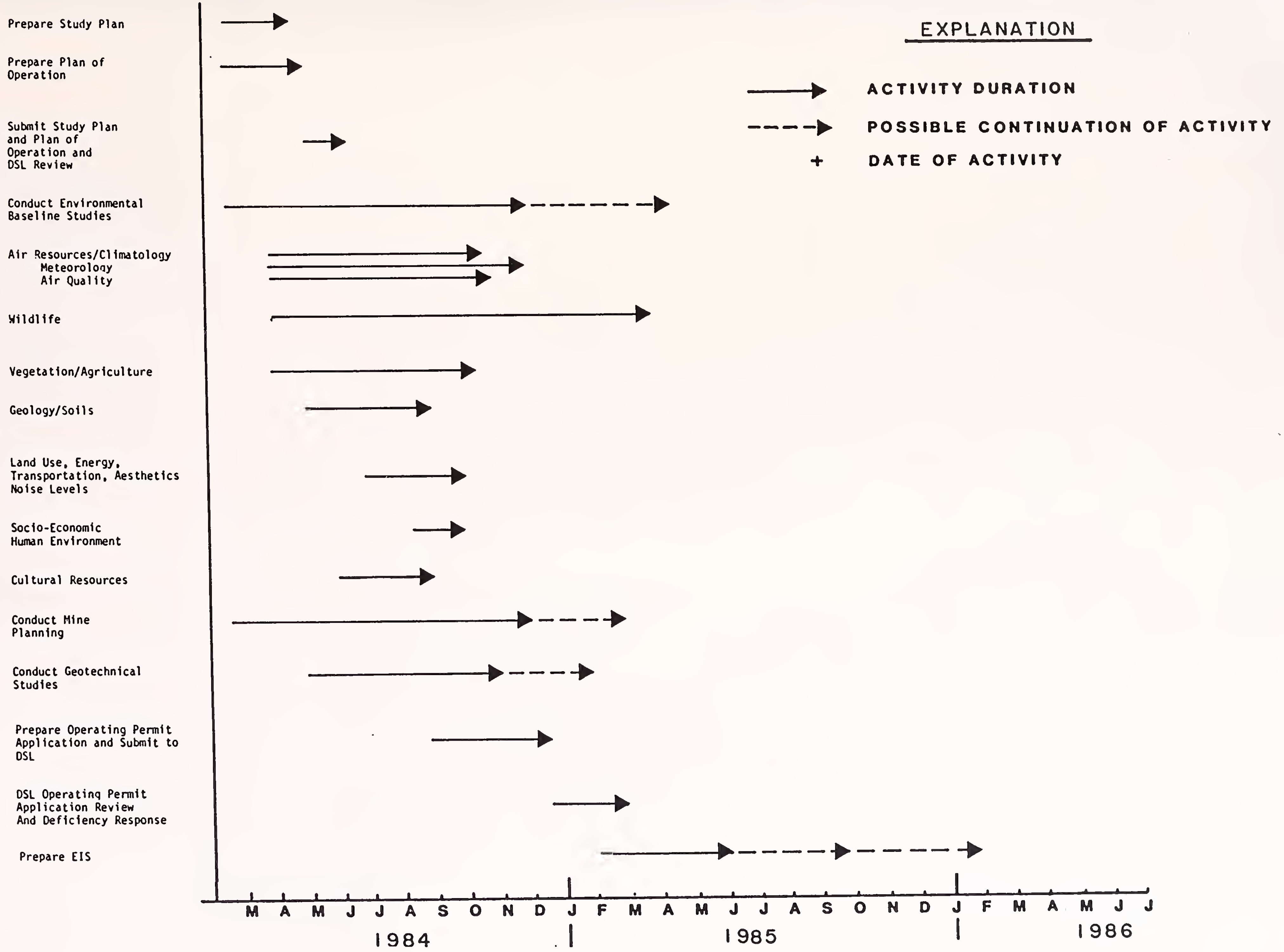
The study will be closely coordinated with the Montana Department of State Lands to ensure the project studies will be acceptable to DSL and will fulfill their technical requirements. The scope, intensity and progress of this study will be closely monitored to ensure it is completed on schedule and meets all the criteria and requirements for baseline environmental investigations. All members of this study team

have worked on past hard rock projects in western Montana and this management system has worked well.



STUDY TEAM ORGANIZATION ANDPRINCIPAL INVESTIGATION

TIMETABLE



ENVIRONMENTAL BASELINE STUDY TIMETABLE - MONTANA TUNNELS PROJECT